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Highlights | 2005-06

Communications Research Centre Canada

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Alan Winter (left), Chair of the Board of Directors for the Communications Research Centre Canada (CRC), reviews last year's Highlights report with Veena Rawat, CRC President.

Message from the Chair

Communications technologies are integral to the success of Canadian enterprises, and innovation is a critical factor in our country's ability to market goods and services around the world. The Information and Communication Technology (ICT) industry and their customers in every sector are driving this innovation, developing software and hardware that has the same fundamental importance in our homes or offices as electricity.

The Communications Research Centre Canada (CRC) is a government research organization which complements these research and development activities, bringing unique and outstanding expertise to bear on significant technical challenges. Last year, CRC's contribution included an important submission to the Minister of Industry's Telecommunications Policy Review Panel, which examined the most appropriate policy and regulatory framework for Canada's telecommunications system in the 21st century. Similarly, CRC's technical progress last year has made a significant impact on the telecommunications, broadcasting and Internet industry, and users of those networks.

The accomplishments outlined in this year's *Highlights* reflect CRC's crucial role in sharing its expertise with academic institutions and other partners in the public and private sector, with benefits that extend to all Canadians. Many different collaborations lie at the heart of an ongoing story of common interests, shared needs and fruitful collaboration. It is a story in which I am proud to participate, and for which I thank the many individuals and agencies, including the CRC clients, staff, Board and Industry Canada, that have fostered such success.



Alan Winter

Message from the President

As you will see from this year's *Highlights*, CRC continues to define the forefront of research work in Information and Communication Technology (ICT). These activities represent progress in such key areas as broadband technologies for rural and remote areas, defence communications, network security and public safety, all of which has a major impact on the Canadian economy and quality of life.

CRC also addressed issues related to the introduction of a number of new wireless technologies, such as ultra-wideband, WiMAX and others as part of its mandate to help government define policy and regulations and serve as a scientific authority in satellite communications. CRC also contributed extensively to standards development in organizations such as the Institute of Electrical and Electronic Engineers (IEEE) and the International Telecommunication Union, among others. The organization is also meeting some of the challenges created by the convergence of telecommunications, broadcasting and the Internet, a trend that is rapidly expanding the capabilities of devices ranging from cellular phones and laptop computers to radios.

Another priority has been technology transfer and commercialization, which is bringing CRC's research into the marketplace, as well as transferring knowledge to university students to shape highly qualified people for the Canadian economy. These efforts have not only helped many start-up companies make their first commercial appearances, but also earned awards and other recognition for CRC personnel. CRC is now working under the auspices of the Public Service Modernization Act, which has redefined human resources planning and labour relations in the federal public sector. Within this context the CRC continues to showcase the talent concentrated within our organization, a critical mass of highly qualified people who are proving to be our greatest resource in building Canada's future.



Veena Rawat



(Centre) An aerial view of the Communications Research Centre Canada (CRC) on the Shirleys Bay campus in Ottawa.

(Top) CRC's David Lee points to a newly-installed compact antenna range reflector inside the Research in Advanced Antenna Technologies Laboratory (RAATLAB).

(Bottom) The new Photonics Laboratory at CRC, under construction during the summer of 2006.

About CRC

As Canada's leading research agency in telecommunications for more than half a century, the Communications Research Centre Canada (CRC) has continually defined the cutting edge of this technology sector. Members of this organization have regularly played key roles in shaping specific technical innovations, including the complex regulatory environment that governs the widespread application of emerging technologies. From the design of a new type of antenna to helping government officials in the development of international standards for high definition television broadcasts, the CRC offers the country's most authoritative perspective on communications issues. Among the most challenging of such issues has been the ongoing convergence of

communications technologies, which has blurred the lines that traditionally distinguished radio or television from such newer media as the Internet or telephony. Beyond simply ensuring that different pieces of equipment can interact with one another, CRC researchers are exploring the unprecedented potential offered by this convergence, which could usher in some entirely new products and services. Their efforts have yielded concrete results, in the form of software and hardware that is making its way into marketplaces in Canada and around the world. Canadians stand to benefit from this progress, just as they have previously benefited from CRC's earlier telecommunications work, building the connections that have come to define our global economy.

Did You Know?

- While digital television broadcasting promises to bring an unprecedented calibre of sound, images and interactive services into our homes, innovations by CRC mean this technology will need far less room on the electromagnetic spectrum than the frequencies currently allocated to existing television channels.
- The human ear may be the ultimate judge of sound, but organizations like Dolby, Phillips, Panasonic, Samsung and NASA find it valuable to measure the performance of their hardware automatically, using the System for the Evaluation of Audio Quality (SEAQ) software developed by CRC.
- The licensing of Fibre Bragg Gratings (FBG) technology has made CRC the most successful publicly-funded research organization in North America in terms of Intellectual Property revenue or number of licenses, or patents applied or patents issued, when normalized with respect to R&D budgets. FBG enhances the data-handling speed and power of optical networks, allowing some waves of light to pass while filtering out others. This critical technology combines a significant collection of patents that has subsequently been licensed to more than 30 major clients around the world over the past decade.
- Radio is no longer about your traditional radio tuner — it can work with any wireless device, including your cell phone, pager, laptop computer or satellite receiver. Software Defined Radio (SDR) enables different types of hardware to treat these transmissions like any other software program. CRC is at the forefront of developing the tools to create such programs, with the Software Communications Architecture - Reference Implementation (SCARI) Software Suite program that enables the development of hardware platforms to handle various radio transmission modes.

Strategic Priorities



(Left) The antenna of the Microwave Light Organized Network (MILTON) Experimental System, a pilot operation in India.

(Right) CRC researchers discuss UCLP project work with international partners using a four-way videoconference in the CRC BADLAB.



Broadband Access

Broadband access activities are aimed at carrying out research that will help deliver cost-effective solutions for access to broadband services in rural and remote communities in Canada. These activities will also assist in the U-CAN program that has been proposed by the Telecom Policy Review Panel report, providing ubiquitous broadband throughout all regions in Canada that the market is not likely to serve on its own by 2010. These activities will lay the foundation for projects that could help to provide such access in other parts of the world.

- CRC has established a pilot operation in India that showcases the feasibility of a cognitive wireless system with the capability to sense the radio environment for interference and identify poor quality links. Called the Microwave Light Organized Network (MILTON) Experimental System, it was delivered and installed at the Indian government's Centre for Development of Telematics (C-DOT) facility in Bangalore, and has completed a year of near flawless operation.

Radio Spectrum

Industry Canada regulates the radio spectrum, a mandate that calls for a solid technical base on which to make proper decisions and policies. CRC research in this area supports spectrum policy and regulation development, more efficient use of the allocated spectrum and a better utilization of new frequency bands.

Internet and Convergence

After some 20 years of implementation, the Internet continues to evolve, making it important for Canada to remain at the forefront of developments and improvements. In particular, Internet at higher access speed is becoming ever more readily available to larger numbers of consumers at a reasonable cost, a trend that is leading to convergence among various competing and complementary systems for delivering information. CRC is exploring the implications and potential of such trends, enabling government to make the most informed policy decisions in this area.

- User Controlled LightPath (UCLP) software allows users to treat network resources as objects, enabling more powerful and flexible use of an entire network. CANARIE, Canada's advanced Internet development organization, issued a major contract to develop services based on this technology, with work at CRC being carried out in collaboration with the University of Ottawa, the Spanish i2CAT Foundation, and Inocybe of University of Montreal.

Network Security and Public Safety

The increasing use of network infrastructure for communications, commerce, defence and other applications is paralleled by a growing awareness of the need for network security and the role this infrastructure can play in public safety. In partnership with other Canadian organizations, CRC is examining the needs and capabilities

of technology in this field, including the security of wireless networks, a matter of increasing concern.

■ Software Defined Radio (SDR), which enables different types of computing and information technology hardware to handle radio transmissions with the Software Communications Architecture - Reference Implementation (SCARI) program from CRC, could find significant use in public safety and search and rescue activities. The National Search and Rescue Secretariat, an independent federal agency, has asked CRC to test a dual-band, protocol converter for this application.

Defence Communications

The Department of National Defence (DND), through Defence R&D Canada (DRDC), is one of CRC's major clients, engaging researchers with tasks conducted on a cost recovery basis. Most of these activities are closely tied to CRC's expertise and to DND's requirements for communications R&D, creating a mutually beneficial relationship. DND's present interests include interoperability of communications networks, quality of service, network security and high-capacity wireless systems.

■ CRC is collaborating with several nations in developing a new high-data-rate narrowband waveform intended to meet requirements for NATO network-enabled operations.

■ CRC co-chairs the Narrowband Waveform expert group of NATO's VHF/UHF Radio Working Group, which is responsible for the development of interoperability standards in military tactical radio systems.

Applications

Much of the growing interest and demand for broadband technology is driven by applications that require a high level of quality service. With access to various national and international communications networks, CRC is well-positioned to demonstrate some of the most novel and promising of these applications, such as on-line education or medical systems, with a particular focus on a high degree of social or industrial benefit. Applications are also demonstrated for remote network access using CRC's satellite communications facilities.

■ CRC participated in the tele-homecare REACH project (Remote Assertive Community Homecare), funded jointly by the European Space Agency and Canadian Space Agency, which installed on patient's premises specialized nursing stations for physician and nurses to communicate remotely with psychiatric patients via satellite links.

In a field demonstration to Canadian Forces Land Staff, CRC showcased new tactical communications capabilities that would be possible through the use of wireless ad-hoc network architectures and high data-rate network-capable radios.



Technology Transfer and Commercialization

During 2005-06, 28 new patent applications were filed and nine new patents were issued. The patent portfolio has 246 active patents and applications, based on 104 distinct inventions. Total revenues generated during this period were \$983,800.

Taking R&D activities to the global marketplace is one of the key ways for Canada to expand its economic potential. CRC is among the organizations leading this process, and examples from the past year include:

- The development of an Integrated Development Environment (IDE) for Software Defined Radio (SDR) technology, which enables different types of computing and information technology hardware to handle multiple radio transmissions protocols. This product, named the Software Communications Architecture - Reference Implementation (SCARI) Software Suite, has been honoured with the

CRC presently has 464 agreements worldwide for the use of its intellectual property and 153 active contracting-in agreements.

“Excellence in Technology Transfer Award” from the Federal Partners in Technology Transfer, a federal network dedicated to recognizing the public good and economic value created in government research organizations. Transferred to 14 major companies nationally and internationally, SCARI has an educational version and has been downloaded more than 7,000 times from its Web site (www.crc.ca/rars).

- CRC’s well-established strength in the field of Bragg grating optical component research has been heralded by the acceptance and publication of 17 international peer reviewed scientific journal publications, three outstanding submissions to peer reviewed journals, 14 conference publications, an invited talk, the issuing of two US patents and the filing of four US patents. These activities have spawned several national and international collaborations, including the transfer of technology to manufacturers.



CRC’s Advanced Radio Systems Group was recognized by the Federal Partners in Technology Transfer (FPTT) for their work with Software Defined Radio (SDR) technology (see page 15).

This Year's Activities

Broadband Access

■ CRC participated in the formation of a new IEEE 802.22 standardization project aimed at developing the air-interface for Wireless Regional Area Networks (WRAN), especially suited for extending broadband access in rural areas by taking advantage of the lightly used TV broadcast spectrum in these low-density areas. This TV broadcast spectrum has the advantage of better RF signal propagation resulting in larger coverage cells (up to some 30 km radius) and therefore allowing sufficient subscriber bases for cost-effective broadband access operation in these rural areas. The 802.22 standard, which will have an international applicability because of its cognitive radio features, should result in the user terminals being available at low cost because of high volume production. CRC has provided for the vice-chairmanship of the working group, has made sure that the requirements for bringing broadband access to rural Canada are well covered, and brought in a number of contributions on technology, systems and interference aspects to help advance the work of the group. The plan is to deliver an approved 802.22 standard to the industry in early 2008, so that low cost equipment complying with the standard becomes available on the market in early 2009.

■ CRC has been extensively involved in the development of the new IEEE 802.16h standard that will allow WiMAX to have a coexistence capability, allowing for a more equitable sharing of the electromagnetic spectrum.

CRC has developed the world's first truly cognitive radio technology for broadband delivery, which is now being field tested in Canada and India.

The new standard will support spatio-temporal sharing of common spectrum, allow for white space identification, and provide a method for ad-hoc radio networks to communicate common electromagnetic sensing criteria in an altruistic manner.

■ The Broadband Applications and Demonstration Laboratory (BADLAB), a CRC facility providing integrated fibre-optic, satellite, and radio communications systems, took advantage of its network capability to host various interactive multi-media events and demonstrations. The subjects of these activities included CA*net 4, satellite links to remote and rural communities as part of the Virtual Classroom program (MusicGrid, Library and Archives Canada, and Algonquin College Interior Design projects), and the National Capital Institute of Telecommunications tele-haptics project.

Radio Spectrum

■ CRC has been studying Ultra Wideband technology, which promises to bring wireless, high-speed connections into homes and offices. This work has focused on the challenges posed by measurements and sharing problems, with researchers participating in working groups of the International Telecommunications Union's Radiocommunications Sector, as well as simulating a novel butterfly-shaped dipole antenna to address these issues.

With partners, CRC produced a working example of a stream containing 12 different radio programs in a single Digital Audio Broadcasting multiplex.



CRC researchers Siva Palaninathan (left) and Ibrahim Haroun (right) prepare for Ultra Wideband testing.

■ CRC-COVLAB software was used to study coverage of Digital Video Broadcasting Handheld (DVB-H) systems, research that is being conducted with three different Canadian industrial clients.

■ CRC helped demonstrate the feasibility of Digital Audio Broadcasting (DAB) and Digital Multimedia Broadcasting (DMB) technologies in Mexico City, one of the world's largest urban centres, using an L-band distributed emission system.

■ CRC is collaborating with International Partners on the Assessment of Radiowave Propagation for Satellite Communication and Navigation Systems in Tropical and Sub-Tropical Areas. CRC is focusing on cloud attenuation modeling and fading dynamics, as part of a larger evaluation of tropical propagation impairments, model testing, and compilation of rain-rate data.

■ CRC is collaborating with Carleton University in the European consortium Wireless World Initiative New Radio (WINNER), tasked with developing the air interface for mobile radio systems to become capable of offering more than the current "third generation" services for voice communications and data.

Internet and Convergence

■ CRC-developed software components were used to create a full real-time Digital Audio Broadcasting (DAB) and Digital Multimedia Broadcasting (DMB) transmission chain. This kind of compact, flexible, open and low-cost

platform has many potential uses in the rapidly growing field of mobile multicast communications.

■ Virtual reality systems, enabling a user to simulate travel through a remote multimedia environment,

are being developed by CRC in collaboration with academic and government partners. The work is part of an NSERC Strategic grant, "Virtual Navigation in Image-Based Representations of Real World Environments" (NAVIRE), employing a large database of images to model any particular setting.

■ CRC has joined the European Reconfigurable Ubiquitous Networked Embedded Systems (RUNES) project, developing localization and routing techniques that would make it possible to deploy a sensor network within tunnels.

■ Users may soon be able to discard their television or DVD remote and simply tell these machines what to do verbally, thanks to a technology known as the voice-enabled electronic program guide (Voice EPG) that is on the verge of entering the marketplace. Working with South Korea's Electronics and Telecommunications Research Institute (ETRI), CRC concluded the first phase of an ongoing collaboration on such voice-enabled broadcast applications.

■ CRC is working with the Canadian Space Agency, Telesat, and Industry Canada's National Satellite Initiative program to deploy, in northern Canada, Digital Video Broadcasting Return Channel Satellite (DVB-RCS) terminals that would be compatible with the ANIK F2 ability to provide this capability.

■ CRC has been developing a prototype system for efficiently forwarding multicast information in an on-line, Mobile Ad-hoc Network, as part of work being carried out with the Internet Engineering Task Force (IETF).

■ The CRC's Networked Media Laboratory, one of many organizations that were developing Web 2.0 applications before the term was coined, has released the final version of an on-line system that enables students to demonstrate their compliance with educational standards. This software has been used by a new Canadian company as a prototype, generating sufficient sales to American universities to allow the company to achieve financial viability.

CRC has the only laboratories in North America dedicated to the evaluation of advanced digital radio and television technologies.

Network Security and Public Safety

■ The potential for interference between digital television broadcasting and signals transmitted for public safety communications at 700 MHz, such as police or fire radio, is the focus of the Radio Advisory Board of Canada's 700 MHz Joint Working Group (JWG). The CRC prepared a test plan for laboratory evaluation and field tests were conducted with the CBC in Ottawa and Montreal.

■ The current and future requirements of public safety and emergency services are being explored by CRC.

As part of a survey of system interoperability, regulations, policy, and market information, CRC is matching aspects of relevant services with various agencies or companies that can provide the appropriate technology.

■ CRC has designed protocols for Mobile Ad-hoc Networks (MANETs), self-organizing wireless networks of mobile nodes that do not require pre-existing infrastructure, as part of the Interoperable Networks for Secure Communications (INSC) project.

Defence Communications

■ In a field demonstration that was part of the ISTAR military exercise in Petawawa, CRC designed, tested and deployed a secure, classified, wireless broadband

communications network to interconnect various battlefield sensors and provide broadband connectivity back to the central base. The experimental IP-based tactical radio made it possible to implement an electronic battlefield for integrated Intelligence, Surveillance and Reconnaissance.

■ CRC chairs the NATO Research Task Group investigating interference and other effects of Power Line Telecommunications technology on the HF spectrum.

■ CRC is working in collaboration with DRDC Ottawa on the development of a military version of the CRC Spectrum Explorer unit, a powerful software tool CRC developed to monitor the increasingly complex RF communications spectrum.

■ CRC has been developing components critical to the interoperability of the next generation of NATO's Tactical Area Communication System, a mobile, survivable, flexible and secure real-time network to support all communication needs in a battlefield setting. CRC's contribution made a significant impact on standards being considered for NATO future Army coalition deployments. This was tested in field trials with research teams from a number of NATO nations in 2005 and 2006.

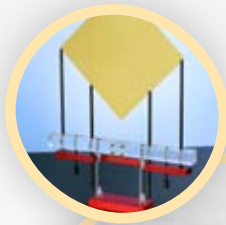
■ CRC has refined neural network classifiers, which have proven capable of distinguishing satellite imagery of naval vessels with significant accuracy.

CRC researchers developed Spectrum Explorer software to monitor use of the electromagnetic spectrum for regulatory and research purposes.

CRC researchers have developed an Integrated Development Environment (SCARI Software Suite) for the development of Software Defined Radio (SDR). The Suite is being licensed worldwide.

A lab view of CRC Spectrum Explorer software, operated by CRC Research Engineer Ky-Bao Huu Ho. The system is used in the monitoring of spectrum usage across the country.





(Left) Fixture and assembly of a holographic antenna, developed by CRC and DRDC.



(Centre and right) The Department of National Defence (DND), through Defense R&D Canada (DRDC), is one of CRC's major clients.



- In collaboration with DND, CRC has developed a prototype thin profile, high-gain antenna based on holography principles.

- CRC has initiated a DRDC Technology Demonstration Project, exploring the design of Self-Healing Autonomous Sensor Networks that would provide enhanced situation awareness in military operation environments.

Applications

- Architects and industrial designers at many different locations will be able to collaborate in real-time, sharing computational resources, geometry datasets, and multimedia content, thanks to work being conducted by CRC, Carleton University's School of Architecture, and NRC. The \$1.5 million, one-year Participatory Design Studio project is supported by CANARIE's Intelligent Infrastructure Program, and the work is taking advantage of CRC's expertise in User Controlled LightPaths to develop these new Web services.

- Through a partnership with University of Toronto's Joint Centre for Bioethics,

and Global E-Health and Innovation Network, CRC researchers are developing broadband technologies to support the activities of these organizations in education and outreach, as well as citizen engagement.

- CRC has developed a novel multichannel loudness meter, which is being presented to the Radiocommunications Sector of the International Telecommunications Union, as the basis for an international standard to be used by broadcasters around the world. The technology will be distributed to several regional broadcast organizations around the world and used in a loudness project sponsored by the World Broadcasters Union.

- CRC was involved in the successful integration of the European DVB-RCT (Digital Video Broadcasting, Return Channel Terrestrial) downlink system into the American Advanced Television Standards Committee digital television infrastructure, to create a new interactive multimedia datacasting system. This is the first time that DVB-RCT, which was developed for the European DVB-T system, has been used in conjunction with the American system.

CRC researchers discovered the photosensitivity of optical fibre, which has been recognized as one of the five most important advances for optical communications.

Collaborations

■ CRC continues its collaboration with The Department of Indian and Northern Affairs, Arctic Council and University of the Arctic in support of collaborative ICT initiatives amongst circumpolar countries. An Arctic Council ICT Network Workshop was attended in northern Finland in September.

CRC is on the forefront of Canadian satellite communications initiatives, managing all of the major satcom programs on behalf of the Canadian Space Agency.

■ A memorandum of understanding between CRC and Japan's National Institute of Information and Communications Technology has been extended for three more years. Future collaborations may include research in the areas of terrestrial wireless and optical technologies.

■ A two-year collaborative research agreement was signed with the University of Ottawa to conduct joint research on advanced audio source coding for application in broadcasting over the Internet and other digital wireless transmission systems. Within the scope of that agreement, a M.Sc. student conducted NSERC-supported research work at CRC, producing a paper that won an award at the Fourth Annual Conference on Communication Networks and Services Research in Moncton, NB.

■ CRC signed a three-year agreement with the National Taiwan University to develop wireless sensors for biomedical and environmental applications, supported by the National Science Council of Taiwan and the Chip Implementation Center in Taiwan.

■ Under a Natural Sciences and Engineering Research Council (NSERC) grant, CRC continues to work with Laval University to build hardware and software to test the use of antenna diversity on a digital television return channel.

■ CRC is collaborating with Rohde & Schwarz and Samsung Electronics on a possible improvement to the North American Digital Television System, testing how compatible such a system would be with existing broadcast hardware.

■ Teaming up with Industry Canada's Spectrum, Information Technologies and Telecommunications gateway and Quebec regional staff, CRC is improving the direction-finding capability of Spectrum Explorer, a powerful software tool developed by CRC to monitor wireless communications spectrum.

■ CRC worked with Telesat Canada, Lawson Health Research Institute, The Peel Corporation, and VaaSah Incorporated to launch the Remote Assertive Community Homecare (REACH) program. The program demonstrated the viability of an e-health communications platform that, within six months, had provided 700 video visits between patients and care providers, reducing their overall travel time by more than 385 hours as well as reducing the number of days those patients spent in hospital by 112 days.

■ In a continued collaboration with Defence R&D Canada (DRDC) Ottawa, CRC worked in the areas of network security and radio surveillance; and with DRDC Valcartier in the area of information management over limited-bandwidth and energy-constrained wireless links.

■ CRC renewed its agreement to work with a major telecom company for two more years on projects that include Public Safety and Emergency Service Evolution, Wireless Network Security Dependability and Reconfigurability, and Converged Network Architecture for Canadian Telecom Operators.

The e-health communications platform used by the Remote Assertive Community Homecare (REACH) program enables patients suffering from mental illness to receive quality treatment at home.



■ An agreement was struck between CRC and Quebec City to study and evaluate advanced broadband wireless communication systems for public safety services.

■ CRC continues to work closely with India's Centre for Development of Telematics in the development of a MILTON cognitive radio base station technology that will support the IEEE 802.16h standard. This standard will support multiple-network coexistence and will mitigate congestion in the licence-exempt (LE) bands. The collaborative development seeks to produce a base station technology that will support up to nine co-channel networks on the same LE channel, while delivering services such as VOIP and data.

■ As a participant in several of the European Union's 6th Framework projects, CRC collaborated on 4th Generation Wireless (4G) technology and Dependable Security by Enhanced Reconfigurability (DESEREC), a multi-disciplinary, coordinated effort to increase the reliability of critical open and interconnected information systems.

■ CRC has engaged in a wide range of private sector collaborations, including work with:

- Advantech AMT/Allgon of Sweden on a power amplifier linearization technique;
- Telesat on the next generation of beam forming networks, multi-media protocols, optical links and a satcom system for satellite communications;
- Nortel Networks on the licensing of codec software for the IEEE Standard 802.16;
- ISR Technologies, Spectrum Signal Processing, and Ultra Electronics on the licensing of CRC's Software Defined Radio (SDR) tools to enhance product marketability;
- Telemus on the development of spectrum monitoring systems for an Asian navy;
- EMS on advanced signal processing for the detection of search-and-rescue satellite signals;
- mobile telephony providers on convergence of radio access systems with end-to-end quality of service, and
- evaluation and analysis of the deployment of Cisco's Mesh Access Point in outdoor environments in southern Ontario.



(Right) The receiving ground station component of Cospas-Sarsat, an international satellite system used by search-and-rescue services throughout the world.

(Left) Cospas-Sarsat is used in emergency situations such as the plane crash depicted here.



CRC's Impact



(Right) Robert Gagnon adjusts an antenna in preparation for testing the Digital Television Mobile Lab on Parliament Hill.

(Left) Louis Thibault (left) and Michel Lavoie demonstrate CRC-SEAQ software, a System for the Evaluation of Audio Quality.

- CRC is developing and demonstrating new broadband applications such as tele-health and tele-education for the benefit of rural and remote communities.
- Developed by CRC, the Microwave Light Organized Network (MILTON) Experimental System is the world's first truly cognitive radio technology for broadband delivery. MILTON is now being field tested in Canada and India and should make its way to many other markets.
- CRC has used Metalorganic Chemical Vapor Deposition to grow GaAs substrates patterned with an SiO₂ mask, a technique that could yield novel optical waveguide and switch structures with improved electrical and optical performance.
- The work done by CRC on distance and electronic learning projects has led to many Canadian school boards acquiring broadband connectivity and applications software.
- CRC is managing the Canadian Space Agency's Cascade communications technology demonstration program, which is studying the feasibility of space-based transfer of very large data files. CRC is the Co-Principal Investigator for the Enhanced-Polar Outflow Probe (EPOP) payload on the CASSIOPE satellite, and designer of the radio wave propagation and plasma flow instrument.
- Specialized CRC software has been licensed to public agencies and private firms, in Canada and around the world. These licenses included CRC-COVLAB, modeling software that performs coverage prediction and analysis for various types of communication systems, as well as CRC-COVLITE, which estimates the path loss during propagation.
- CRC is tailoring the CRC-COVLAB software to meet the needs of Radio-Canada, which has called for specialized functions and tools required to prepare technical briefs according to Industry Canada's Broadcast Procedures and Rules (BPR).
- The CRC-SEAQ software, a System for the Evaluation of Audio Quality, was licensed to Broadcast Australia, LG Electronics (Korea), Samsung Advanced Institute of Technology (Korea), Sumnet Co. Ltd (Korea), Intel Corporation (USA), Dolby Laboratories (USA), the New Mexico State University (USA), and the Technical University of Norway.
- CRC has been looking at ways of enhancing the performance of Digital Broadcast Multimedia Receivers, examining approaches such as antenna diversity, Multiple Input-Multiple Output antennas, improved channel estimation, and synchronization and cancellation schemes.
- As the co-chair of the Independent Laboratories Group of the Video Quality Expert Group (VQEG), an international organization dedicated to evaluating objective methods for the assessment of video quality in digital video, CRC is working on the planning and organization of testing methods for the assessment of multimedia video applications, as well as participating as a testing facility. The results of this work will allow international standards organizations, such as the International

Telecommunications Union, to select the standard objective methods required by industry to monitor and improve the quality of the video delivered to users.

- CRC offered formal contributions to the Minister of Industry's Telecommunications Policy Review Panel, which addressed technology trends such as the future of wireless systems, cognitive radio, software defined radio, wireless sensor networks, Mobile Multimedia Broadcasting, Broadband Access using digital television technologies, and single frequency networks for digital television.
- To help small- and medium-sized enterprises bring wireless communications technology to the marketplace, CRC leads the Canada Network of Wireless Centres project (CWCnet). The International Institute of

Telecommunications (IIT) of Montreal received \$3.3 M in funding from Canada Economic Development for Quebec Regions to support work on this project.

- CRC participated in the Software Human Resource Council's conference (SHRC) and presented the future on wireless communications. A not-for-profit organization working with industry, education, associations and government, SHRC has selected this technology as one of the central features of its road map for the future.
- Working closely with the Radio Advisory Board of Canada, CRC assists in spectrum planning activities, regulatory activities, and determining the needs of the Canadian broadcasting industry.

Kudos

As part of National Public Service Week, five Public Service Awards were presented to CRC individuals and groups in a ceremony held on June 9, 2006. These awards were given in recognition of outstanding R&D accomplishments, and for the positive image these individuals have brought to the public service in the last year. The winners were:

1. **The Advanced Radio Systems Group**, for their contribution to the development of Software Defined Radio (SDR), including communications architecture and related tools. The winners are Claude Bélisle, Steve Bernier, Hugues Latour, François Lévesque, Sébastien Gauthier and Charles Auger. The Advanced Radio Systems Group received an "Excellence in Technology Transfer" Award from the

Federal Partners in Technology Transfer (FPTT).

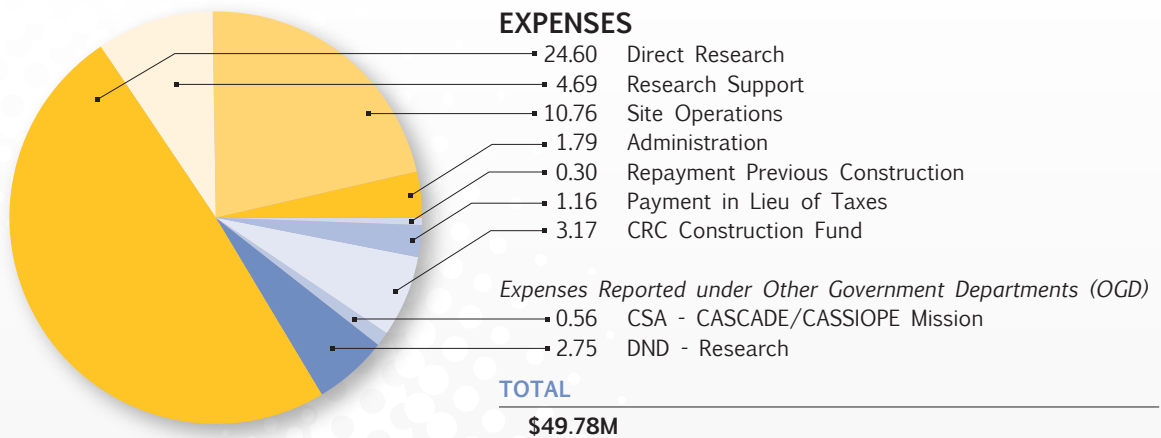
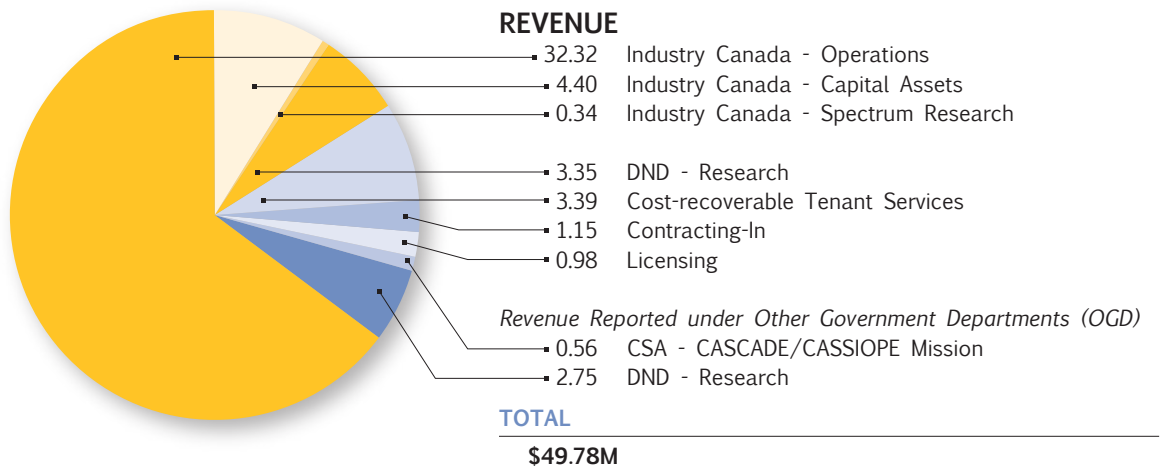
2. **Gilbert Soulodre, Michel Lavoie and Scott Norcross**, for their article "Objective Measures of Listener Envelopment in Multichannel Surround Systems," published in the Journal of the Audio Engineering Society (Volume 51, Number 9) in September, 2003. These three researchers have been chosen to receive the Audio Engineering Society's (AES) Publications Award 2006.

3. **Dr. Stephen Mihailov, Dr. Dan Grobnić, Mr. Robert Walker and Dr. Ping Lu**, for their work on narrowband fiber-optic phase-shifted Fabry-Perot Bragg grating filters for atmospheric water vapor lidar measurements. They were selected by the NASA Inventions and Contributions Board for an award.

4. **Dr. Alex Vukovic**, recipient of the Outstanding Performance Award for his plenary talk at the Communication Systems and Networks International Conference in 2005.

5. **Dr. Xianbin Wang, and Dr. Yiyang Wu**, for their paper entitled "Transmitter Identification Using Embedded Pseudo Random Sequences," which appeared in the IEEE Transactions on Broadcasting in September 2004. Dr. Wang and Dr. Wu were recipients of the IEEE Scott Helt Memorial Award in October 2005. This award is given to recognize exceptional publications in the field and to stimulate interest in and encourage contributions to the fields of interest of the IEEE Broadcast Technology Society.

Finances 2005-2006



Notes:

(1) CRC receives funding from a number of government and non-government sources. In 2005-06, Industry Canada provided 74.4% of CRC's funding. Other government funding was provided by the Canadian Space Agency and the Department of National Defence to carry out R&D, and to cover costs related to their residence on the CRC campus. Revenue from the private sector is generated through the licensing of intellectual property and contracted R&D.

(2) Construction of the Laboratory for Photonic Components & Systems Research will be completed in 2006-07. A lab equipment purchase plan and various capital projects were approved and funded by IC in 2005-06 and 2006-07 for a total of \$4M. Due to long lead times with PWGSC and uncertainty on future year funding, some projects were delayed.

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